

Ground-level NO₂ Concentrations Inferred from OMI

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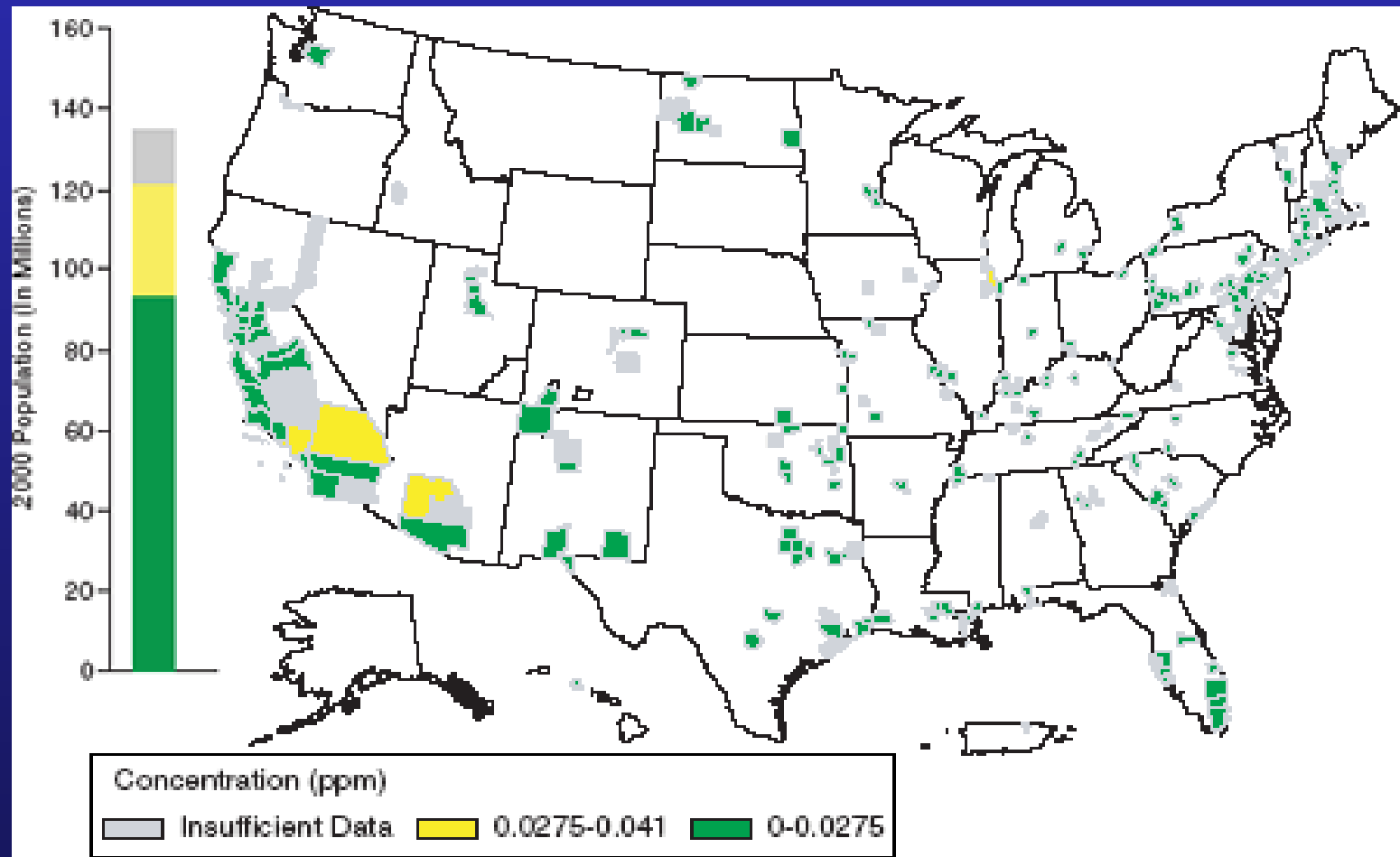
Edward Dunlea, CIRES

Joseph Pinto, EPA

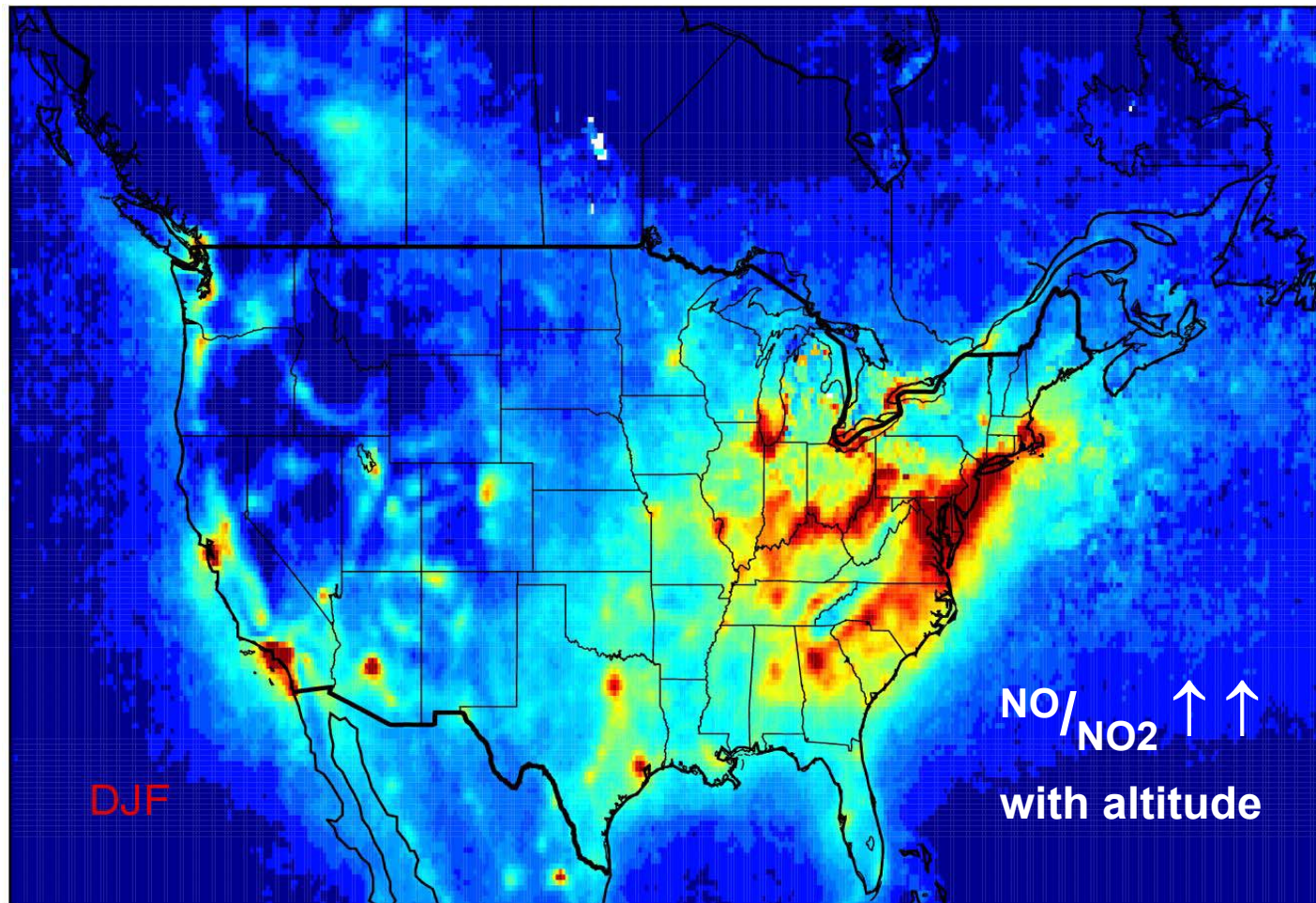
Large Regions Have Insufficient In Situ NO_2 Measurements for Air Quality

NO_2 Toxic Pollutant Associated with Mortality
In Situ Monitors Contaminated with Reactive Nitrogen

Highest NO_2 maximum quarterly mean by county, 2001



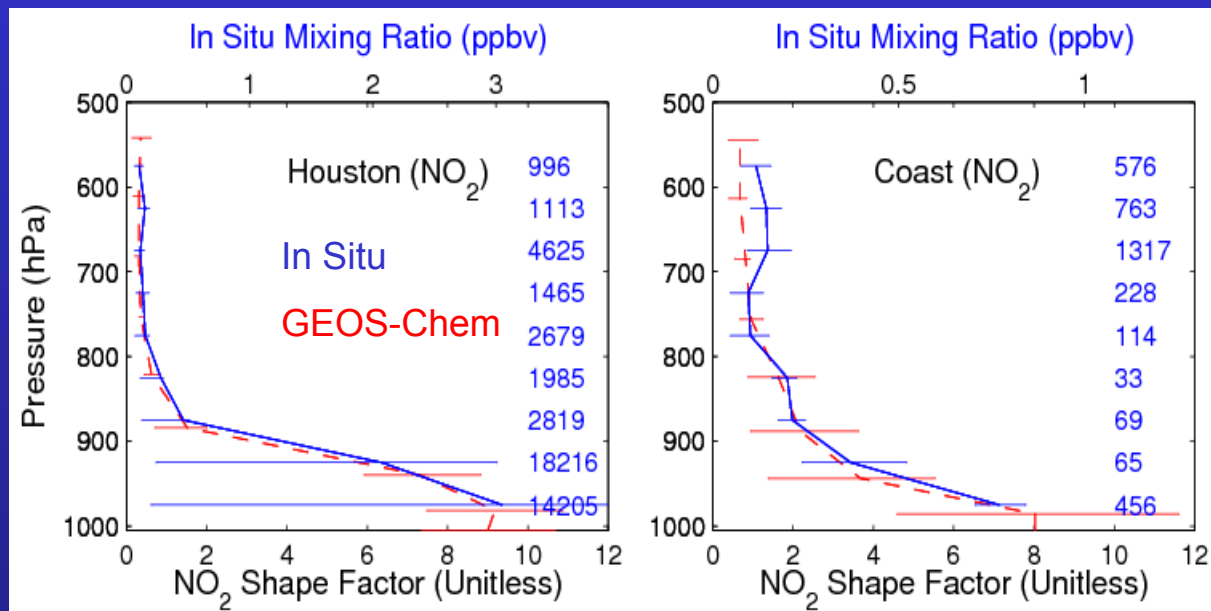
OMI Tropospheric NO₂ Column Proxy for Surface Concentration



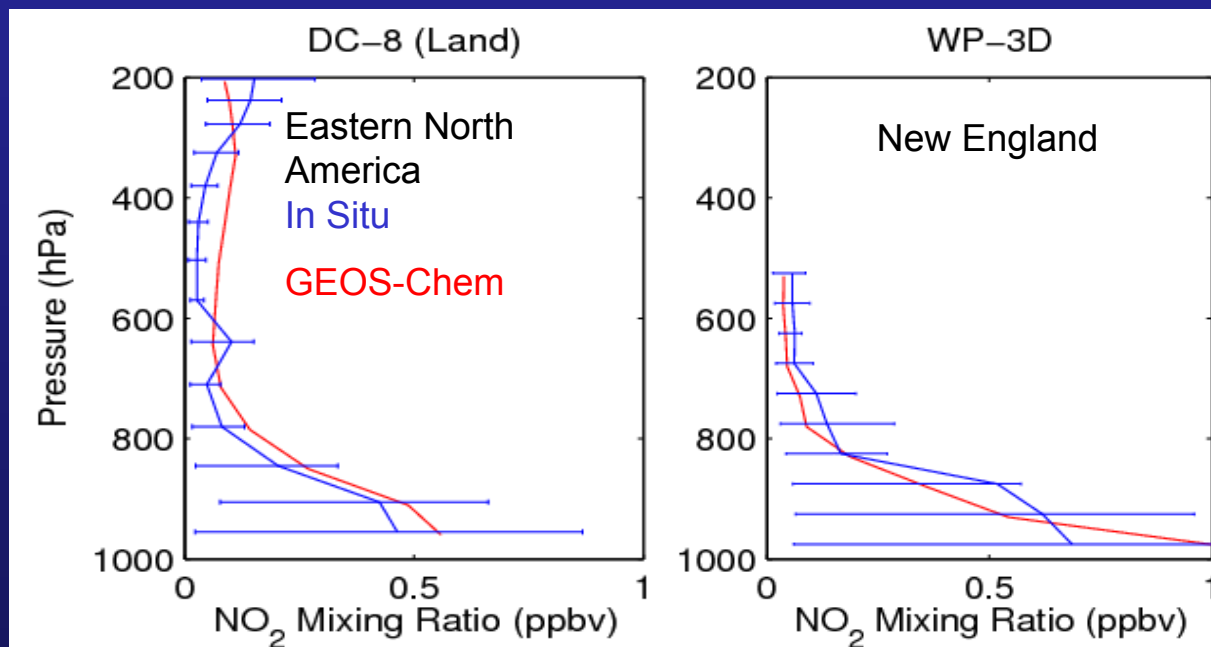
trop. NO₂ column [10^{15} molec. cm⁻²]



Tropospheric NO₂ Column Strongly Related to Ground-level Concentration over Land



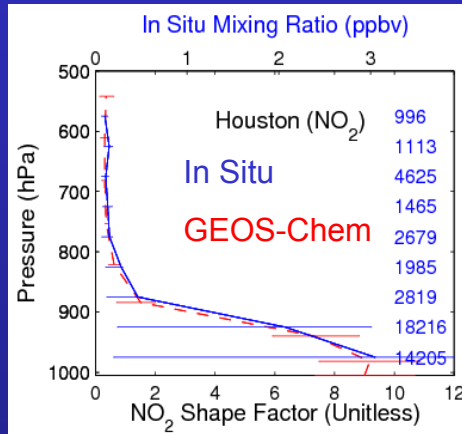
Texas AQS
Martin et al., 2004



ICARTT
Martin et al., 2006

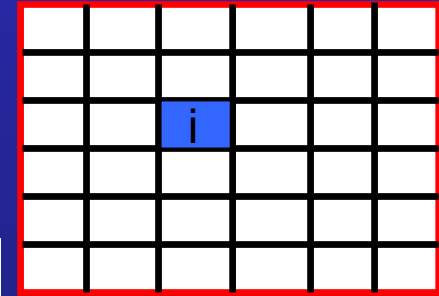
Approach to Infer Surface NO₂ from OMI

GEOS-Chem NO₂ Profile



OMI Local Information

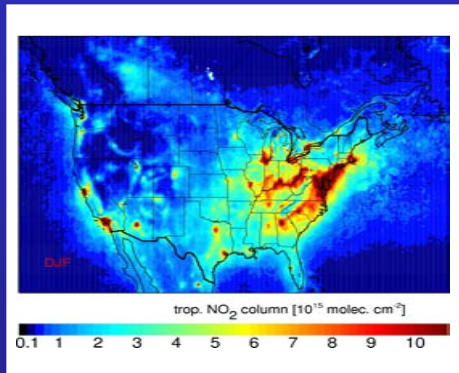
$$\overline{\Omega}_{\text{OMI}} = \sum_n \Omega_{\text{OMI}}(i)$$



GEOS-Chem Grid

$$S_{\text{OMI}} = \Omega_{\text{OMI}}(i) \left[\frac{S_{\text{GEOS-Chem}} \left(\frac{\Omega_{\text{OMI}}(i)}{\overline{\Omega}_{\text{OMI}}} \right)}{\Omega_{\text{GEOS-Chem}} + \left(\Omega_{\text{OMI}}(i) - \overline{\Omega}_{\text{OMI}} \right)} \right]$$

OMI Tropospheric NO₂ Column



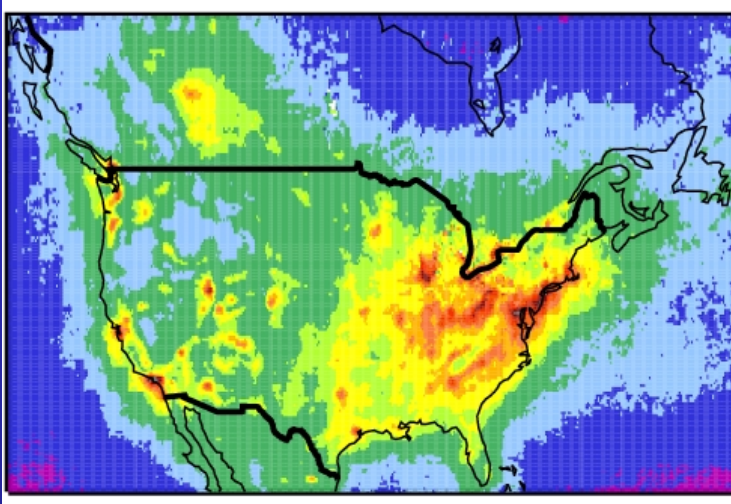
S → Surface NO₂

Ω → Tropospheric NO₂ column

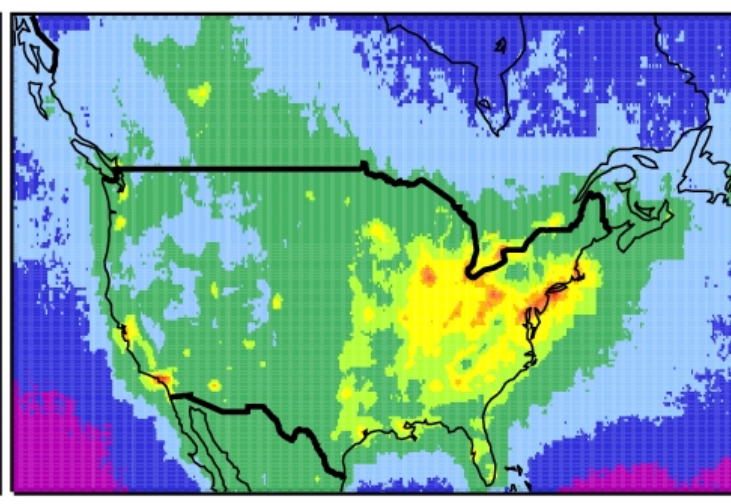
100% error in GEOS-Chem surface NO₂
 → < 10% error in derived surface NO₂
 in polluted areas

Surface NO₂ for 2005 Inferred from OMI (standard product)

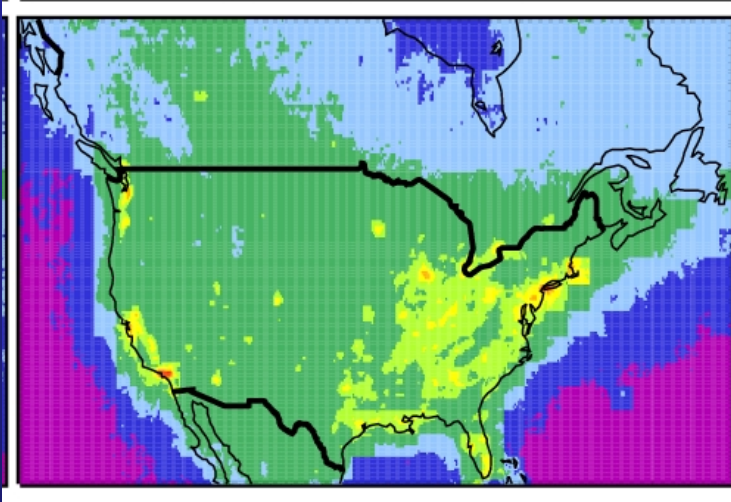
DJF



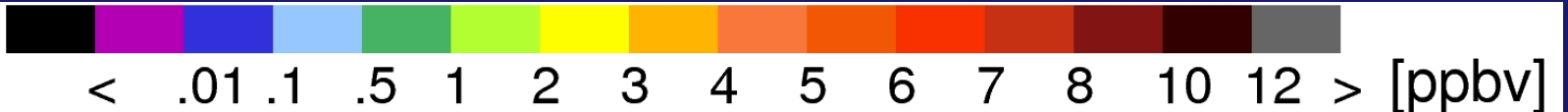
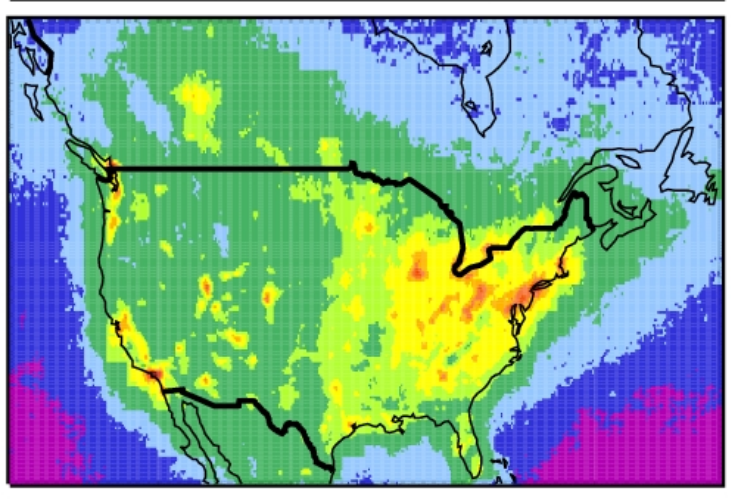
MAM



JJA



SON



Correction for Interference in “NO₂” in Air Quality Networks

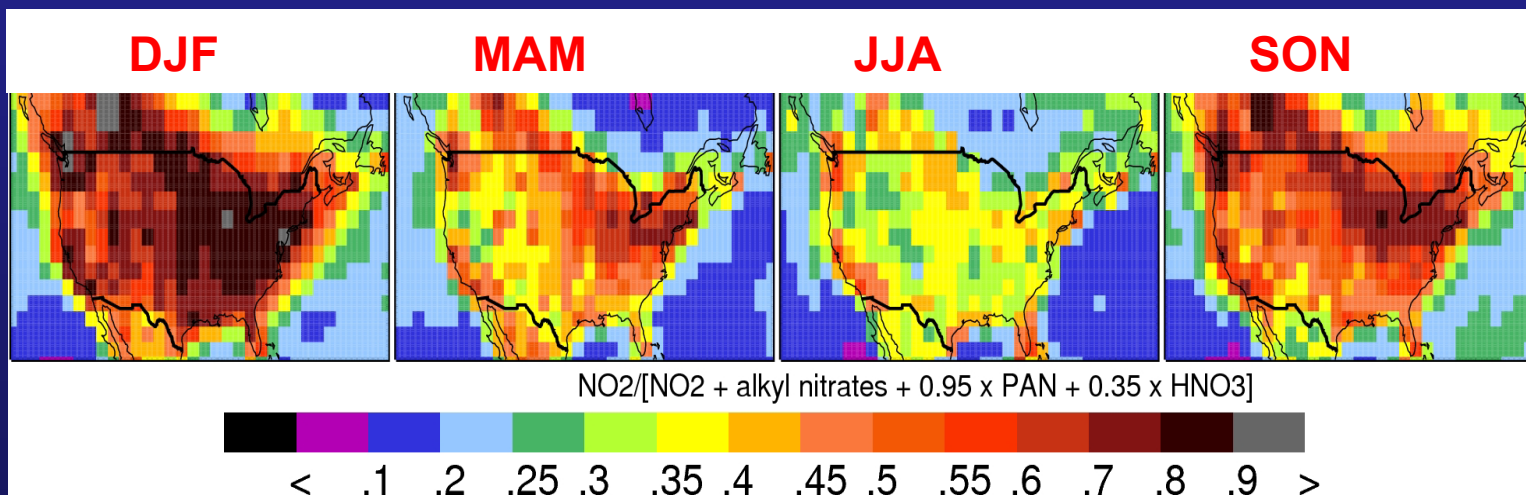
Compounds	Conversion efficiency	Experiments
NO ₂ , ethyl nitrate	~ 100%	<i>Winer et al., 1974</i>
PAN	92%	<i>Winer et al., 1974</i>
HNO ₃ , PAN, n-propyl nitrate, n-butyl nitrate	≥98%	<i>Grosjean and Harrison, 1985</i>
Ammonia, gas phase olefins, NO ₃ ⁻	Insignificant	<i>Dunlea et al., 2007</i>

Difficult issue: Loss of HNO₃ on stainless steel of inlet

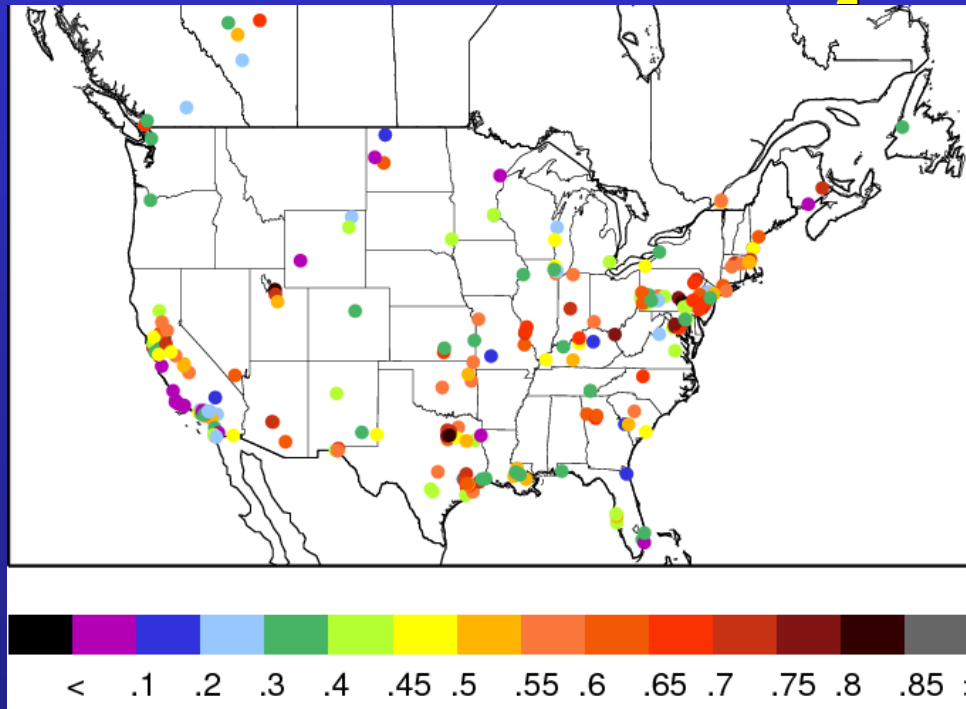
Infer 35% measured from comparison with photolytic converter

Correction Calculated
with GEOS-Chem

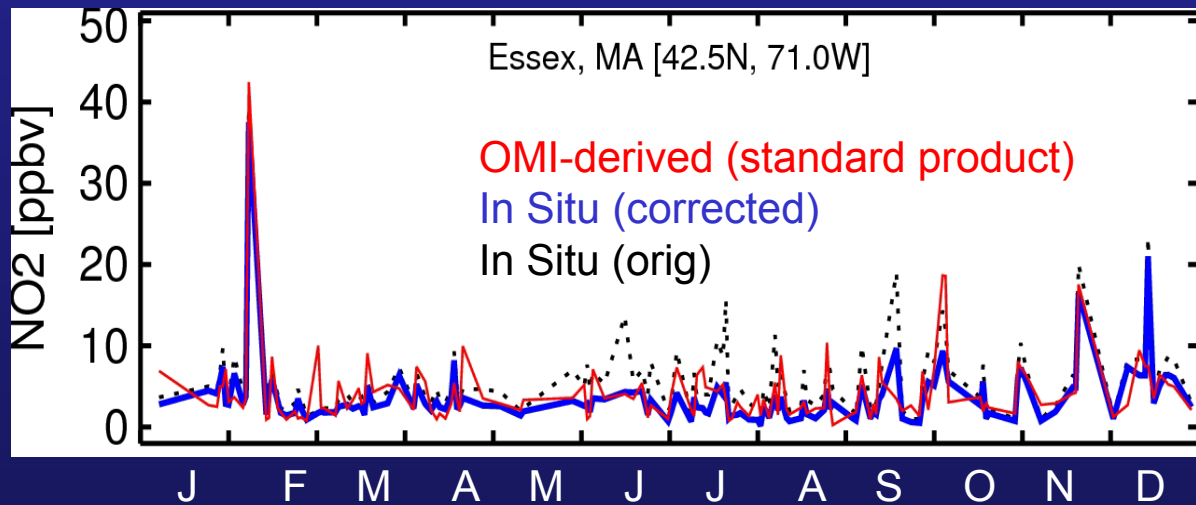
$$\text{Correction} = \frac{\text{NO}_2}{\text{NO}_2 + \text{Alkyl Nitrates} + 0.95\text{PAN} + 0.35\text{HNO}_3}$$



Significant Correlation Between Corrected In Situ and OMI-derived Surface NO₂

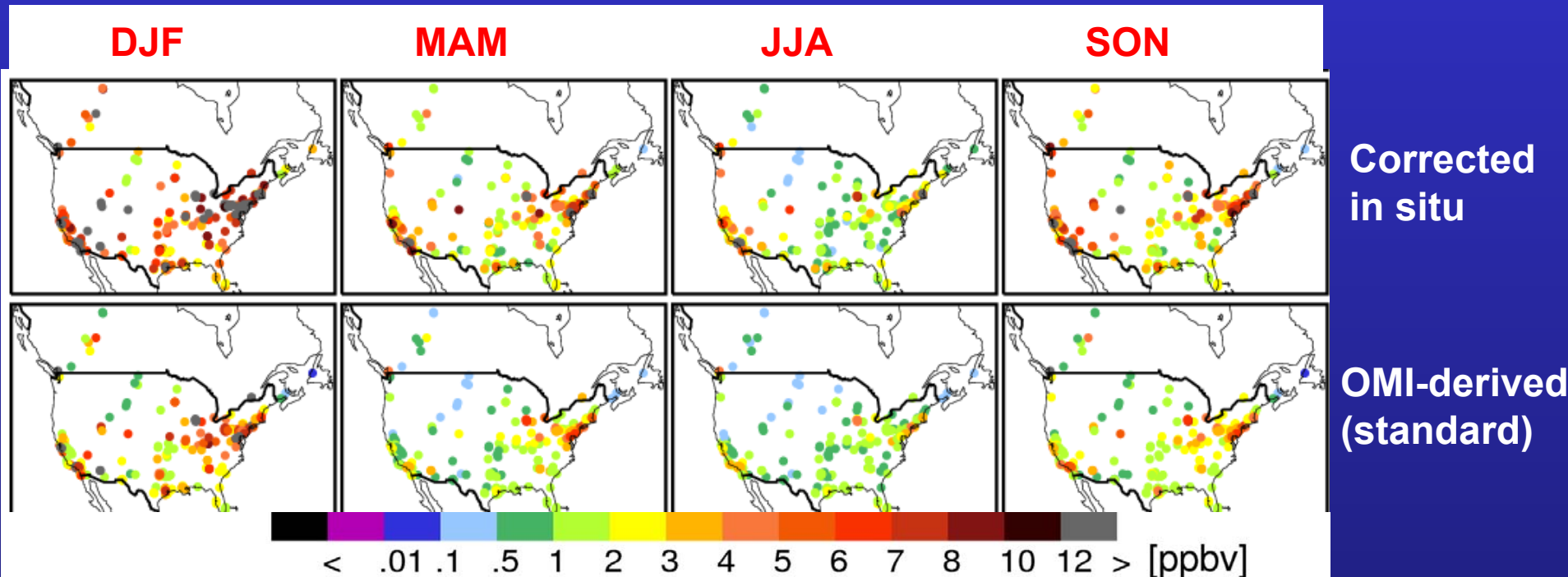


Correlation of Coincident Observations over 2005



Comparison of In Situ and OMI-derived Surface NO₂ for 2005

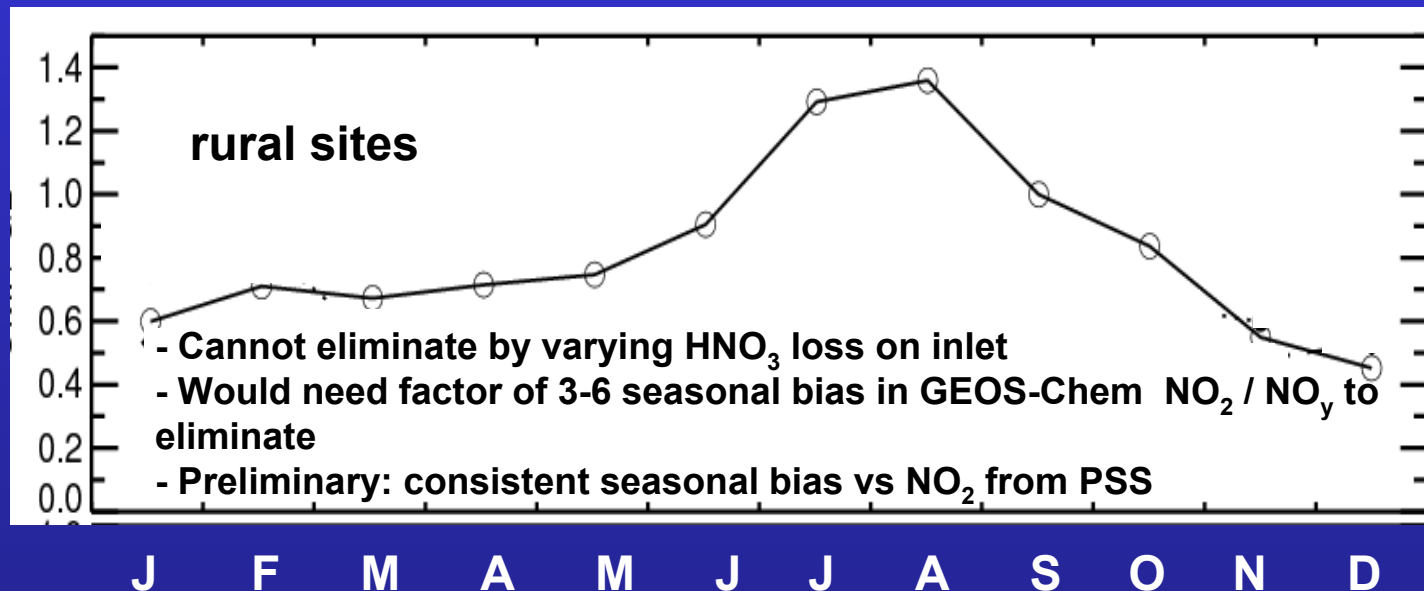
Indirect Validation of OMI



Investigation of Seasonal Bias

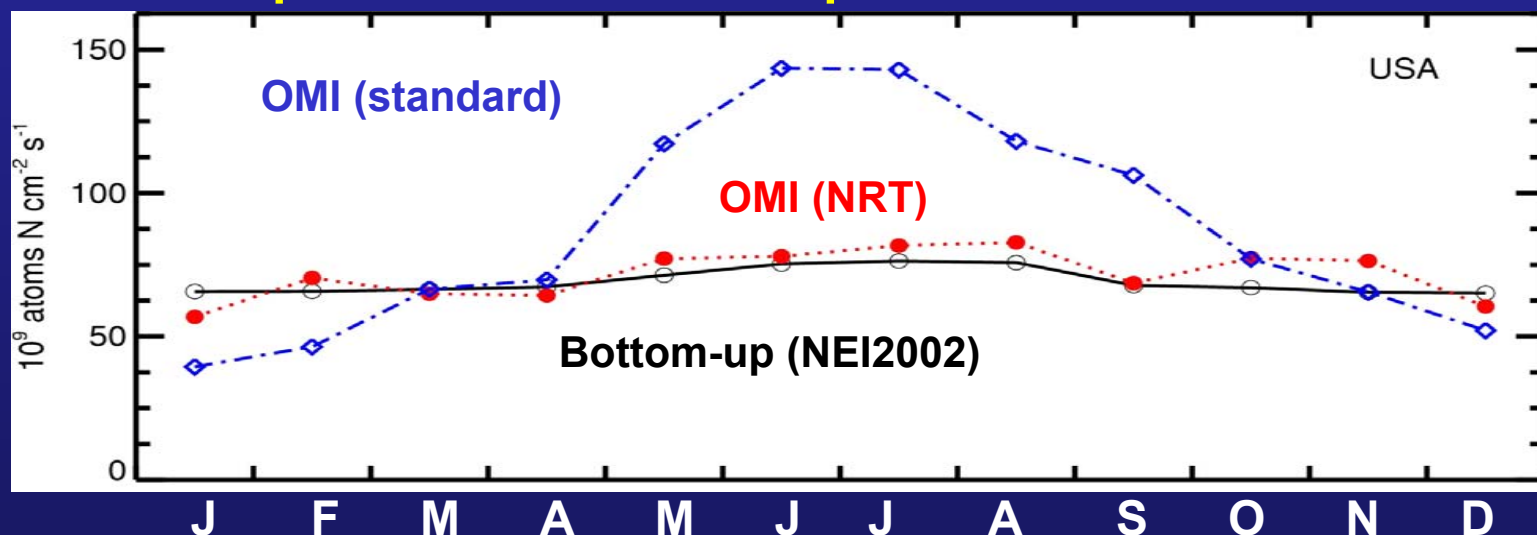
OMI (standard)
In Situ NO_2

2005



Top-down and Bottom-up Emissions over USA

Emissions



Mar 2006 – Feb 2007

Conclusions

Promising satellite-based surface NO₂ estimate

Need for additional validation of surface NO₂ with “true” NO₂

Surface measurements provide indirect validation of NO₂ columns

Acknowledgement

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